

ORIGINAL



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BEFORE THE ARIZONA CORPORATION COMMISSION

RECEIVED

**COMMISSIONERS**

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PAUL NEWMAN  
SANDRA D. KENNEDY  
BRENDA BURNS

2011 MAY 26 P 3:51

AZ CORP COMMISSION  
DOCKET CONTROL

IN THE MATTER OF THE APPLICATION OF ) DOCKET NO. E-01933A-10-0266  
TUCSON ELECTRIC POWER COMPANY FOR )  
APPROVAL OF ITS 2011 RENEWABLE )  
ENERGY STANDARD AND TARIFF )  
IMPLEMENTATION PLAN )

**NOTICE OF FILING DERATE  
CHART**

On November 23, 2010, Tucson Electric Power Company's ("TEP" or "Company") Renewable Energy Standard and Tariff ("REST") Plan was heard during the Arizona Corporation Commission's ("Commission") Open Meeting as Agenda Item No. U-34. During the Open Meeting, TEP agreed to meet with stakeholders in the solar industry with the goal of amending its solar derate chart. TEP further agreed to file any proposals for changes to the derate chart prior to filing its 2012 REST Plan.

On March 8, 2011, TEP held a stakeholder meeting regarding amending its derate chart. As a result, the attached derate chart and memorandum were developed in conjunction with AZRISE. TEP hereby files the attached derate chart and memorandum for Commission Staff's consideration and review. The Company has worked diligently with the stakeholders in its service territory to develop these materials, and continues to evaluate the appropriateness of its previously approved derate chart on a case-by-case basis.

Arizona Corporation Commission

**DOCKETED**

MAY 26 2011

DOCKETED BY

1 RESPECTFULLY SUBMITTED this 26<sup>th</sup> day of May 2011.

2 TUCSON ELECTRIC POWER COMPANY

3  
4 By 

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8 and

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13 Original and 13 copies of the foregoing  
14 filed this 26<sup>th</sup> day of May 2011 with:

15 Docket Control  
16 Arizona Corporation Commission  
1200 West Washington Street  
Phoenix, Arizona 85007

17 Copy of the foregoing hand-delivered/mailed  
18 this 26<sup>th</sup> day of May 2011 to:

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25  
26  
27 By 



MEMO: Derating Chart for Non-Tracking PV Systems.  
By: Alex Cronin, UA Physics and AZRISE, March 29, 2011.

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Based on a meeting held Tuesday 3/8/2011 at TEP, a new derating chart for up-front incentives is proposed.

Figure 1: Deratings for up-front incentives.

	East	80	70	60	50	40	30	20	10	South	10	20	30	40	50	60	70	80	West
0	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%
5	90%	90%	90%	90%	90%	90%	95%	95%	95%	95%	95%	95%	90%	90%	90%	90%	90%	90%	90%
10	90%	90%	90%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	90%	90%	85%
15	90%	90%	95%	95%	95%	95%	100%	100%	100%	100%	100%	100%	95%	95%	95%	95%	90%	90%	85%
20	85%	90%	95%	95%	95%	100%	100%	100%	100%	100%	100%	100%	100%	95%	95%	95%	90%	85%	85%
25	85%	90%	95%	95%	95%	100%	100%	100%	100%	100%	100%	100%	100%	95%	95%	95%	90%	85%	85%
30	85%	90%	90%	95%	95%	100%	100%	100%	100%	100%	100%	100%	100%	95%	95%	90%	90%	85%	80%
35	85%	85%	90%	95%	95%	100%	100%	100%	100%	100%	100%	100%	100%	95%	95%	90%	85%	85%	80%
40	80%	85%	90%	95%	95%	100%	100%	100%	100%	100%	100%	100%	100%	95%	90%	90%	85%	80%	75%
45	80%	85%	85%	90%	95%	95%	100%	100%	100%	100%	100%	100%	95%	95%	90%	85%	85%	80%	75%
50	75%	80%	85%	90%	90%	95%	95%	100%	100%	95%	95%	95%	90%	90%	85%	85%	80%	75%	
55	75%	80%	85%	85%	90%	95%	95%	95%	95%	95%	95%	90%	90%	85%	85%	80%	75%		
60		75%	80%	85%	85%	90%	90%	90%	95%	90%	90%	90%	85%	85%	85%	80%	75%		

Notes: Derating for modules in the range 0 to 5 degrees will be 80% because of uncertainties regarding soiling. Modules parallel to roofs with a pitch of 4/12 (18 degrees) facing south qualify 100 of the incentive. Modules parallel to roofs with a pitch of 3/12 (14 degrees) qualify for a 95% of the incentive.

Justification for the chart above is summarized on the website listed below. It is based on the NREL program PVWATTS. This modeling program is widely known, relatively easy to use, and freely available at:

<http://rredc.nrel.gov/solar/calculators/PVWATTS/version1/US/Arizona/Tucson.html>

The chart incorporates meteorological data for Tucson (from the TMY02 database) and a reasonable temperature derating for most PV systems. However, it does not take into account differences between PV technologies, module manufacturers, or installation details other than orientation.



To find deratings, the PVWATTS prediction for annual kWh for a given orientation (tilt and azimuth) was compared to the prediction for a tilt of 32 degrees facing South. Then the following table was used:

Incentive Derating	kWh Reduction	Color Code
No Incentive	64% or lower	purple
70%	65% - 69%	Dark blue
75%	70% - 74%	Green
80%	75% - 79%	Blue
85%	80% - 84%	Pink
90%	85% - 89%	Yellow
95%	90% - 94%	Mustard
100%	95% +	Red

### Discussion of Deratings:

Up-front incentives should be based on annual production in kwh. This directive comes from the Arizona Corporation Commission. It was acknowledged that other factors (such as building aesthetics, peak shaving, schedules of energy values, and desired seasonal outputs) would in principle lead to different charts. However, a production-based chart was agreed upon.

A list of predicted annual kwh/kw for fixed tilt systems in Tucson is shown below.

	East	80	70	60	50	40	30	20	10	South	10	20	30	40	50	60	70	80	West
0	1574	1574	1574	1574	1574	1574	1574	1574	1574	1574	1574	1574	1574	1574	1574	1574	1574	1574	1574
5	1582	1594	1605	1615	1625	1632	1638	1642	1644	1643	1641	1637	1631	1623	1614	1604	1592	1580	1568
10	1582	1605	1627	1647	1665	1679	1690	1698	1701	1700	1696	1689	1678	1663	1645	1623	1603	1580	1556
15	1572	1608	1640	1669	1694	1714	1731	1742	1746	1746	1740	1729	1713	1692	1666	1637	1606	1572	1537
20	1556	1602	1645	1682	1713	1739	1759	1773	1780	1780	1773	1758	1736	1709	1675	1639	1600	1556	1510
25	1536	1590	1640	1686	1724	1755	1777	1793	1802	1802	1794	1774	1748	1715	1679	1636	1588	1535	1479
30	1509	1571	1627	1679	1724	1760	1786	1802	1811	1815	1803	1777	1750	1715	1673	1623	1567	1507	1444
35	1476	1547	1609	1664	1713	1754	1784	1801	1808	1813	1800	1771	1744	1705	1656	1601	1539	1474	1404
40	1440	1516	1584	1643	1695	1735	1770	1789	1796	1801	1784	1756	1728	1683	1629	1573	1509	1439	1362
45	1400	1478	1550	1614	1669	1711	1744	1766	1772	1776	1757	1731	1700	1650	1600	1540	1471	1397	1317
50	1357	1439	1512	1575	1633	1678	1709	1731	1738	1739	1721	1695	1659	1612	1563	1498	1427	1352	1269
55	1310	1395	1470	1533	1587	1635	1666	1684	1693	1690	1675	1648	1611	1568	1515	1450	1383	1306	1221
60	1260	1346	1420	1486	1537	1582	1612	1627	1636	1630	1617	1589	1556	1513	1460	1400	1333	1255	1170

The above values were tabulated by Kevin Koch using PVWATTS with an ac-dc derating of 84%.

A similar list tabulated by Alex Cronin using PVWATTS with an ac-dc derating of 75% is shown below:

	East	80	70	60	50	40	30	20	10	South	10	20	30	40	50	60	70	80	West
0	1401	1401	1401	1401	1401	1401	1401	1401	1401	1401	1401	1401	1401	1401	1401	1401	1401	1401	1401
5	1408	1419	1429	1439	1447	1454	1459	1462	1464	1463	1461	1458	1453	1446	1437	1428	1417	1407	1395
10	1409	1430	1449	1467	1483	1496	1506	1513	1516	1515	1512	1505	1495	1482	1466	1447	1427	1406	1385
15	1400	1432	1461	1487	1509	1528	1543	1552	1557	1556	1552	1542	1527	1507	1484	1458	1430	1400	1368
20	1386	1427	1466	1499	1527	1550	1568	1581	1587	1587	1581	1568	1548	1523	1493	1461	1425	1386	1344
25	1368	1417	1462	1503	1537	1565	1585	1599	1607	1608	1600	1582	1558	1529	1496	1458	1415	1367	1317
30	1344	1400	1450	1497	1537	1570	1593	1607	1615	1619	1608	1585	1561	1529	1492	1446	1396	1342	1286
35	1315	1378	1434	1484	1528	1564	1591	1606	1613	1617	1605	1579	1556	1520	1476	1426	1372	1313	1250
40	1282	1350	1412	1465	1512	1538	1579	1596	1601	1606	1591	1566	1541	1500	1453	1402	1345	1281	1212
45	1246	1316	1381	1439	1488	1526	1555	1575	1581	1583	1567	1544	1515	1471	1426	1373	1311	1244	1171
50	1208	1281	1347	1403	1455	1469	1524	1543	1550	1550	1535	1512	1478	1437	1393	1335	1271	1203	1129
55	1165	1242	1309	1367	1414	1457	1485	1501	1510	1506	1493	1469	1436	1397	1349	1291	1232	1162	1086
60	1121	1197	1265	1324	1369	1409	1436	1450	1458	1452	1441	1416	1386	1348	1300	1247	1186	1116	1039

The kwh reductions determined from PVWATTS by Kevin and myself are exactly the same, and are shown below.

	East	80	70	60	50	40	30	20	10	South	10	20	30	40	50	60	70	80	West
0	86%	86%	86%	86%	86%	86%	86%	86%	86%	86%	86%	86%	86%	86%	86%	86%	86%	86%	86%
5	87%	87%	88%	88%	89%	89%	90%	90%	90%	90%	90%	90%	90%	89%	89%	88%	87%	87%	86%
10	87%	88%	89%	90%	91%	92%	93%	93%	93%	93%	93%	93%	92%	91%	90%	89%	88%	87%	85%
15	86%	88%	90%	91%	93%	94%	95%	95%	96%	96%	95%	94%	93%	91%	90%	88%	85%	84%	81%
20	85%	88%	90%	92%	94%	95%	96%	97%	98%	98%	97%	96%	95%	94%	92%	90%	88%	85%	83%
25	84%	87%	90%	92%	94%	96%	97%	98%	99%	99%	98%	97%	96%	94%	92%	90%	87%	84%	81%
30	83%	86%	89%	92%	94%	96%	98%	99%	99%	100%	99%	97%	96%	94%	92%	89%	86%	83%	79%
35	81%	85%	88%	91%	94%	96%	98%	99%	99%	99%	99%	97%	96%	93%	91%	88%	84%	81%	77%
40	79%	83%	87%	90%	93%	95%	97%	98%	98%	99%	98%	96%	95%	92%	89%	86%	83%	79%	75%
45	77%	81%	85%	88%	91%	94%	96%	97%	97%	97%	96%	95%	93%	90%	88%	84%	81%	76%	72%
50	74%	79%	83%	86%	89%	92%	94%	95%	95%	94%	93%	91%	88%	86%	82%	78%	74%	70%	65%
55	72%	76%	80%	84%	87%	90%	91%	92%	93%	93%	92%	90%	88%	86%	83%	79%	76%	71%	65%
60	74%	78%	81%	84%	87%	88%	89%	90%	89%	89%	87%	85%	83%	80%	77%	73%	70%	65%	60%

The colors here are exactly the same as for the derating chart, except for the values at 0-degrees tilt.

To check PVWATTS, I built a similar program based on a solar position algorithm and a temperature derating. I will provide my program upon request. The kwh reductions predicted by my model agree with the values from PVWATTS to within 1% at most angles. I show my results below:

Deratings from Cronin model (temperature coefficients included)

	East	80	70	60	50	40	30	20	10	South	10	20	30	40	50	60	70	80	West
0	87%	87%	87%	87%	87%	87%	87%	87%	87%	87%	87%	87%	87%	87%	87%	87%	87%	87%	87%
5	87%	88%	88%	89%	90%	90%	90%	91%	91%	91%	91%	91%	90%	90%	89%	89%	88%	87%	87%
10	87%	88%	89%	90%	91%	92%	93%	93%	94%	94%	94%	93%	93%	92%	91%	90%	89%	87%	86%
15	86%	88%	90%	91%	93%	94%	95%	96%	96%	96%	96%	95%	94%	93%	92%	90%	89%	87%	85%
20	85%	87%	89%	92%	93%	95%	96%	97%	98%	98%	98%	97%	96%	94%	93%	90%	88%	86%	83%
25	83%	86%	89%	92%	94%	96%	97%	98%	99%	99%	99%	98%	96%	95%	93%	90%	88%	85%	82%
30	82%	85%	88%	91%	94%	96%	97%	99%	100%	99%	99%	98%	97%	95%	92%	90%	87%	83%	80%
35	80%	84%	87%	90%	93%	96%	97%	99%	99%	99%	99%	98%	96%	94%	92%	89%	85%	82%	78%
40	78%	82%	86%	89%	92%	95%	96%	98%	99%	99%	98%	97%	95%	93%	90%	87%	84%	80%	76%
45	76%	80%	84%	88%	90%	93%	95%	96%	97%	97%	97%	95%	94%	91%	89%	86%	82%	78%	74%
50	73%	78%	82%	86%	89%	91%	93%	94%	95%	95%	93%	92%	89%	87%	83%	80%	76%	71%	67%
55	71%	75%	80%	83%	86%	89%	91%	92%	92%	93%	92%	91%	89%	87%	84%	81%	77%	73%	69%
60	73%	77%	80%	83%	86%	88%	89%	89%	89%	89%	88%	86%	84%	81%	78%	75%	70%	65%	60%

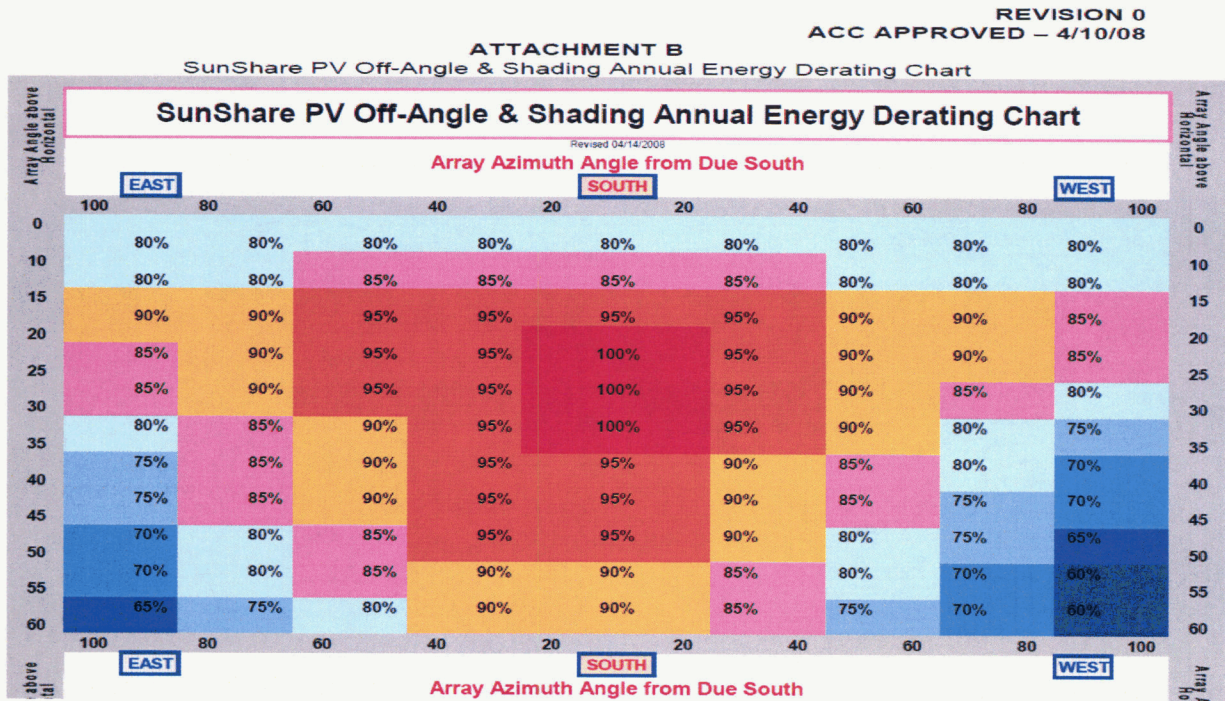
Differences: Cronin's model - PVWATTS model

	East	80	70	60	50	40	30	20	10	South	10	20	30	40	50	60	70	80	West
0	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
5	1%	1%	0%	1%	1%	1%	0%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
10	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
15	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	1%	0%	0%	0%	1%	0%	1%	1%	1%
20	0%	-1%	-1%	0%	-1%	0%	0%	0%	0%	0%	1%	1%	1%	0%	1%	0%	1%	1%	0%
25	-1%	-1%	-1%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%	1%	0%	1%	1%	1%
30	-1%	-1%	-1%	-1%	0%	0%	-1%	0%	1%	-1%	0%	1%	1%	1%	1%	1%	1%	1%	1%
35	-1%	-1%	-1%	-1%	-1%	0%	-1%	0%	0%	0%	1%	1%	1%	1%	1%	1%	1%	1%	1%
40	-1%	-1%	-1%	-1%	-1%	1%	-1%	0%	1%	0%	0%	1%	1%	1%	1%	1%	1%	1%	2%
45	0%	-1%	-1%	0%	-1%	-1%	-1%	-1%	0%	0%	1%	1%	1%	1%	1%	2%	2%	2%	2%
50	-1%	-1%	-1%	0%	0%	1%	-1%	-1%	0%	0%	1%	1%	1%	1%	1%	2%	2%	2%	2%
55	0%	-1%	0%	-1%	-1%	0%	0%	-1%	0%	0%	1%	1%	1%	1%	1%	2%	1%	2%	2%
60	-1%	0%	-1%	-1%	-1%	-1%	0%	0%	-1%	0%	0%	1%	1%	1%	1%	2%	2%	2%	-1%

These are the kWh reductions predicted by my home-made program. The differences between my program and the PVWATTS program are shown in the lower matrix.



For reference, here is the existing TEP derating chart (attributed to Tom Hansen), the newly proposed chart (based on PVWATTS), and the APS chart.



	East	80	70	60	50	40	30	20	10	South	10	20	30	40	50	60	70	80	West
0	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%
5	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%
10	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%
15	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%
20	85%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	85%
25	85%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	85%
30	85%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	85%
35	85%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	85%
40	80%	85%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	80%
45	80%	85%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	80%
50	75%	80%	85%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	75%
55	75%	80%	85%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	75%
60	75%	80%	85%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	75%

